2.1 Stages in the Early Development of the Frog Embryo

Examine the figures of the various stages, cross section slides and models that your instructor will provide to better understand the development of the frog embryo.

Egg

The egg (Figure 2.1) is a large cell, having a volume that is more than 1.6 million times larger than the ordinary cell. It has two regions that can easily be distinguished from each other. The upper layer, the **animal pole**, has dark pigments. The nucleus can also be located in this region. The lower layer, the **vegetal pole**, contains yolk.

Zygote

Once the egg is fertilized, (Figure 2.2) it is called a zygote. The contact with and entrance of the sperm causes the following events:

1. completion of meiosis II
2. rotation of the cytoplasm about 30 degrees relative to the pole
3. formation of the gray crescent
4. formation of a diploid zygote

Locate the **animal** and **vegetal** poles. Identify the **gray crescent,** a small area that is ventral to the animal pole. Its presence indicates displacement of cortical materials as a result of sperm entrance.

Cleavage

The zygote undergoes a series of mitoses (Figure 2.3) that results to its partitioning into smaller cells, the blastomeres. The first cleavage (I) is meridional, running longitudinally through the poles. It forms the 2-cell stage. The second cleavage (II) forms the 4-cell stage. The furrow cuts through the poles and at right angles to the first furrow. The third cleavage (III), which is equatorial, forms the 8-cell stage. It runs horizontally to the plane closer to the animal pole. The succeeding divisions follow the meridional-equatorial pattern producing a mass of cells, the **morula**.

Examine the models on cleavage. Identify the different cellular stages. Note the **differences** between the **animal** and **vegetal** pole cells as cleavage progresses.

Blastula

Continuous cleavage produces a hollow mass of cells, the **blastula** (Figure 2.4). This embryonic stage is characterized by the following:

1. no growth of the embryo takes place.
2. activities are controlled by maternal molecules laid down during oogenesis until, midblastula when zygotic genome is expressed.

Examine the slide on blastula. Identify the **blastocoel**, a fluid-filled cavity. The **blastoderm** is a layer of cells that lines the **blastocoel**. The **macromeres** are large cells ventral to the blastocoel. The **micromeres** are small cells that lie dorsal to the blastocoel.

Gastrula

Gastrulation (Figure 2.5) is characterized by **morphogenetic movements**. The outer epithelial sheets move and enclose the entire embryo, a process called **epiboly**. Cells that were once occupied by the gray crescent **invaginate**. These are pushed inwards through the **dorsal lip of**

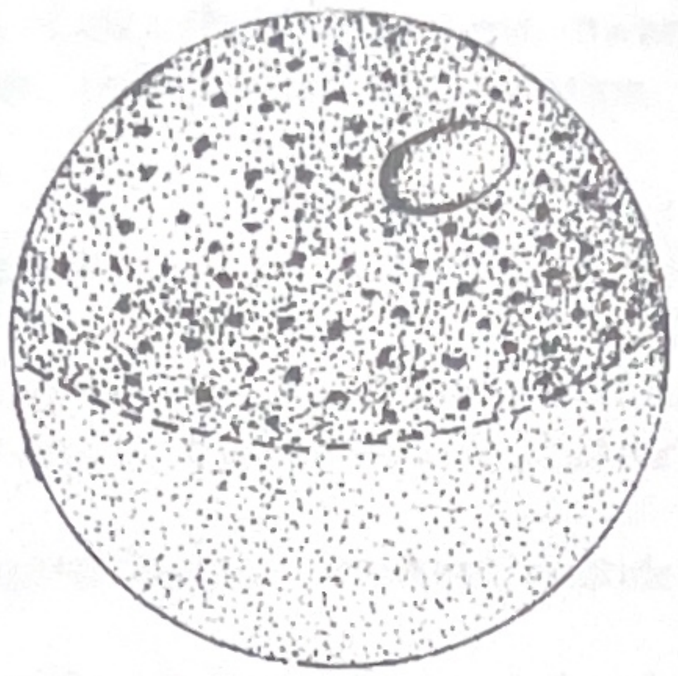


Figure 2.1 Unfertilized egg

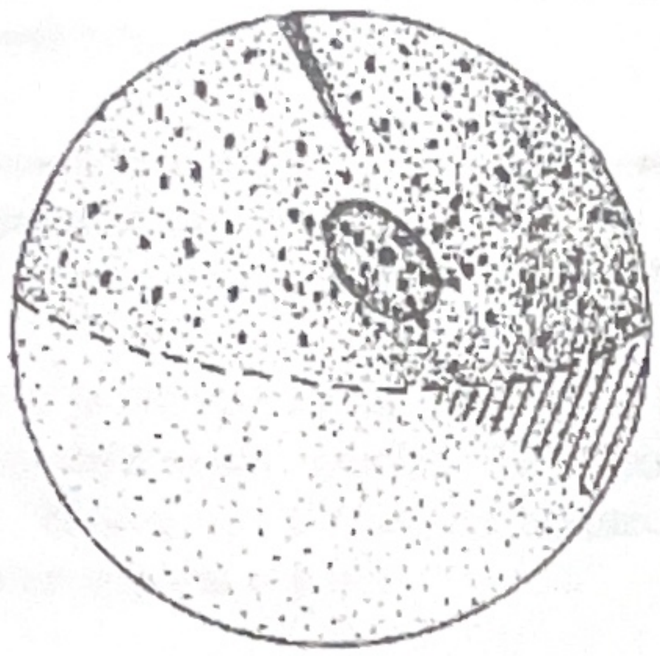


Figure 2.2 Fertilized egg. Note the point of entry of the sperm and the grey crescent

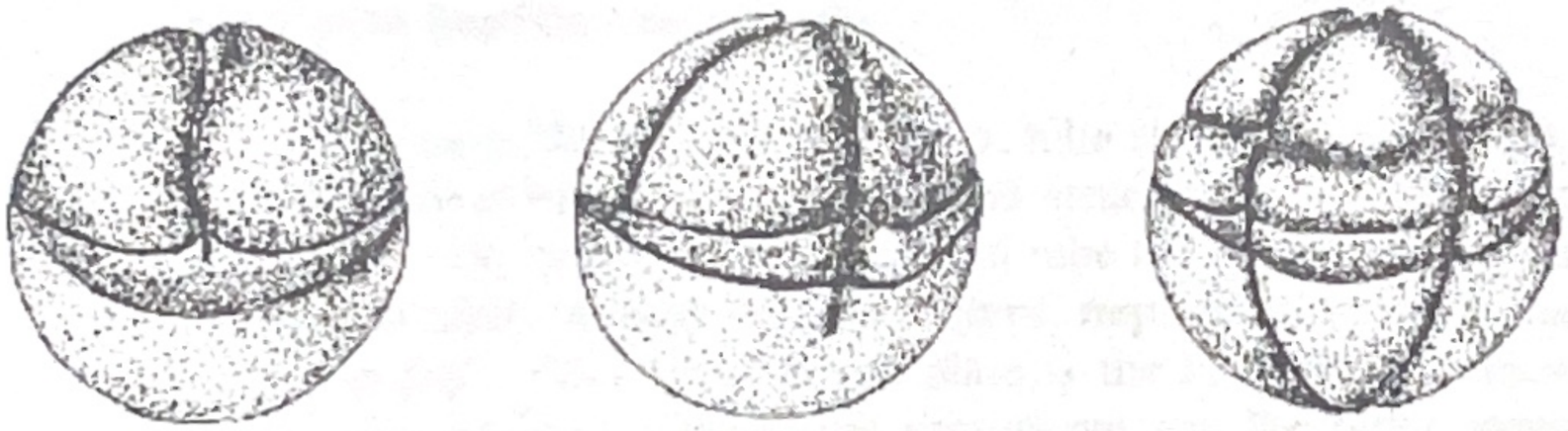
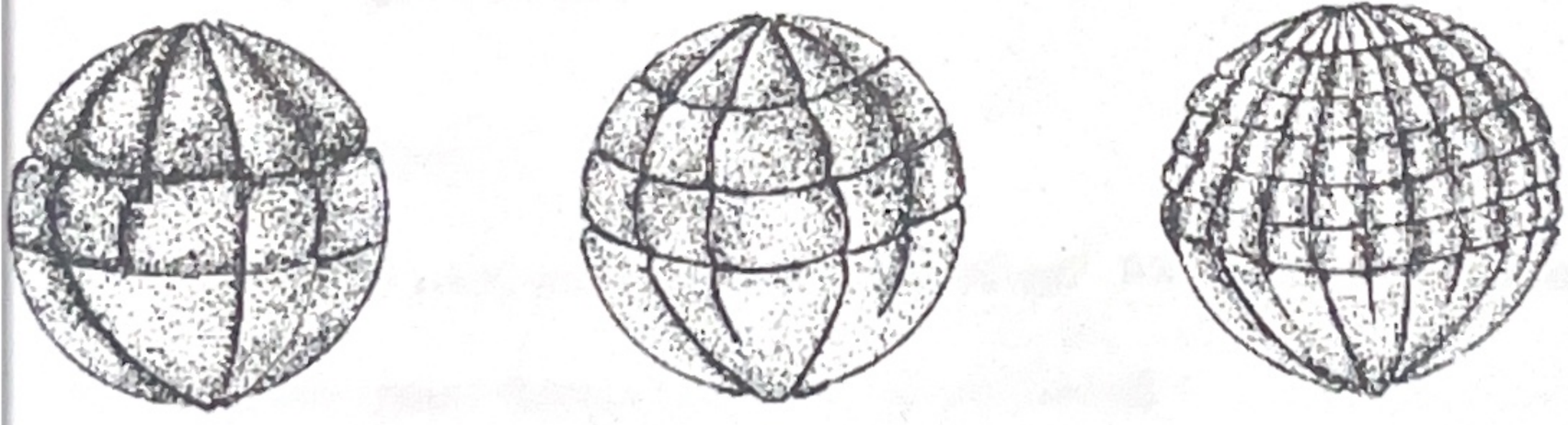


Figure 2.3 Successive stages of cleavage



the blastopore. Later, these cells move inwards to occupy the space between the yolk and the outermost layer. This process is **involution**. At the end of gastrulation, the following are produced:

Blastopore: an opening that will be the future anus.

Dorsal lip of the blastopore: a cluster of cells at the dorsal side of the blastopore. These cells, the **Spemann's organizer**, induce the development of the embryo.

Three germ layers: ectoderm, endoderm, and mesoderm.

Examine the slide on the gastrula. Identify the outer **ectoderm**, the inner **endoderm** and the large dorsal cavity, the **archenteron**, which communicates to the outside through the **blastopore**. The floor of the archenteron consists of the endoderm; its roof is bordered by the **chordamesoderm**.

In advanced gastrula, identify the **ventral lip of the blastopore** . The **yolk plug** is the endodermal projection beneath the dorsal lip of the blastopore. The **mesoderm** is a small strip of tissue that is located between the **ectodem** and the yolk **endoderm**.

Ectoderm gives rise to the epidermis, brain, spinal cord and sense organs. Epithelia of the digestive and respiratory organs, the endocrine glands, liver and pancreas are derived from the endoderm. Mesoderm forms the connective tissues, muscles, bones, cartilage, dermis, circulatory, and urogenital organs.

Neurula

The acquisition of basic vertebrate body plan takes place at this stage. Spemann's organizer induces the ectoderm lying dorsal to it to form the neural tissues. This ectoderm thickens as the neural plate (Figure 2.6 A), forms two longitudinal folds, the **neural folds** (Figure 2.6 B) which later fuse to form the **neural tube**.

Examine the slide on the neural tube stage (Figure 2.6 C). Ventral to the **neural tube** lies the **notochord**, a vacuolated round structure. The **neural crest** lies dorsolateral to the neural tube. On each side of the neural tube the mesoderm has thickened to form the **somites**. The **intermediate mesoderm (mesomere, nephrotome)** is the mass immediately ventrolateral to the somites. The long curved plate is the **lateral plate mesoderm (hypomere)** that is divided into an inner **splanchnic mesoderm** and the outer **somatic mesoderm**. The cavity between the layers is the **coelom** . The somatic mesoderm and the ectoderm form the **somatopleure**. The splanchnic mesoderm and endoderm form the **splanchnopleure**.

Questions

1. From where are the micromeres derived? Why are they much smaller than the macromeres?

2. How many stages of cleavage can you identify?

3. What is the adult fate of the notochord?

4. State five derivatives of the neural crest.

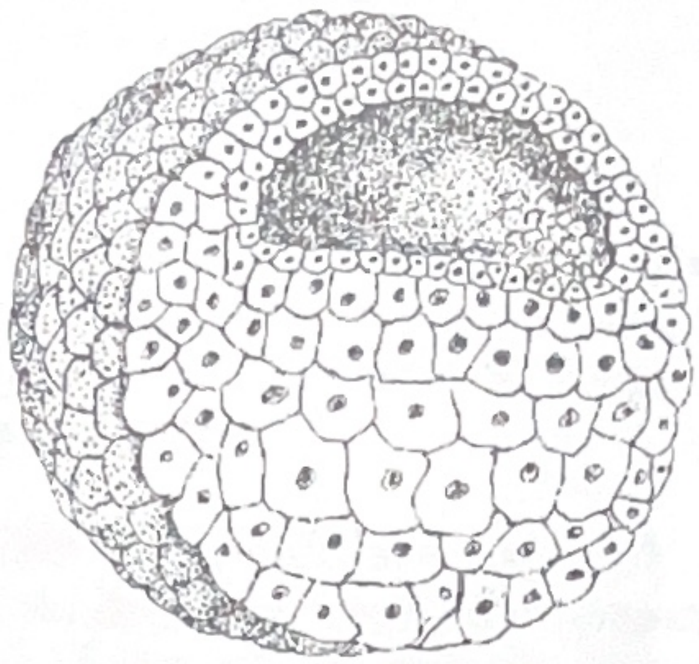


Figure 2.4 Blastula

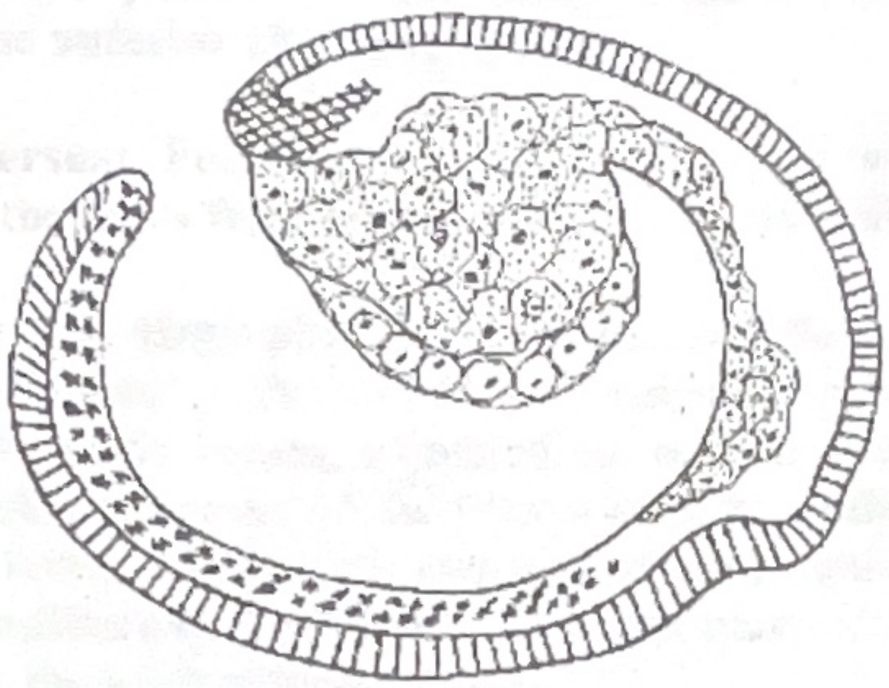


Figure 2.5 Gastrula

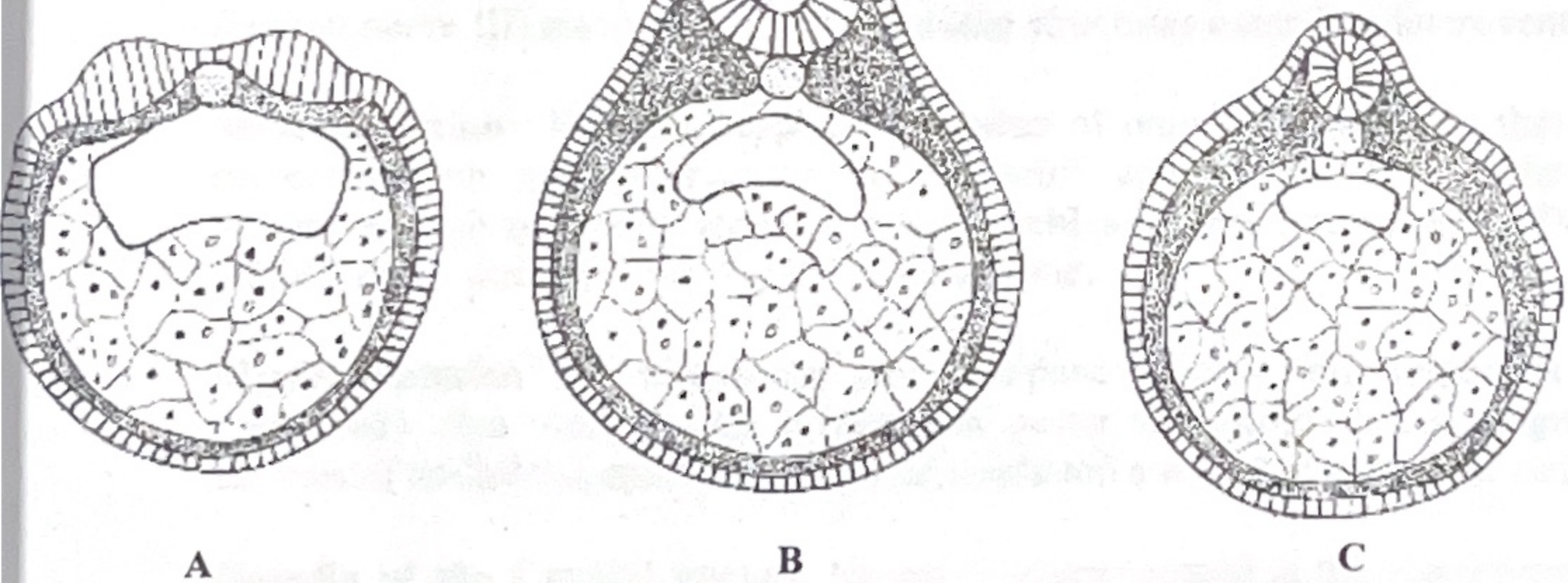


Figure 2.6 Formation of the neural tube:

(A) Neural plate stage
(B) Neural fold stage
(C) Neural tube stage